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Editorial Comment

Fungus Diseases of the Lungs

Only within the past few years have mycotic infections of the lungs and bronchi received the attention they deserve. The importance of renewed interest was in part due to the fact that mycotic infections, which include a wide variety of pathologic agents caused by yeast moulds and fungi, produce in their invasion of the respiratory tract a clinical picture varying from a mild bronchitis to an advanced stage of pulmonary tuberculosis; and the determination of the causative agent and the differentiation from other pulmonopathies can only be made by a most meticulous bacteriological examination of the sputum. Moreover, it is important to recognize this type of infection because many cases respond to potassium iodide.

The general opinion, regarding the rarity of these infections, is probably due to the fact that they are not thought of or searched for until what was diagnosed as pulmonary tuberculosis failed to yield tubercle bacilli in the sputum, and after months and sometimes years search is made for yeast moulds and fungi. Confusion with pulmonary tuberculosis is common because of a history of cough, expectoration of blood streaked sputum, even at times hemoptysis. These symptoms, added to the history of loss of weight and fever of an irregular type, often present a confusing picture. Especially when the physical and roentgenological findings are located in the lung apex, a working diagnosis of tuberculosis is invariably made.

The lung changes and symptoms caused by these fungi resemble almost any type of acute or chronic pulmonopathy. The sputum should be examined for fungi in all chronic suppurative diseases where tubercle bacilli are not found after repeated examination. Even if tubercle bacilli are found, one must have in mind that even these fungi may be causing a co-existing infection with the tubercle bacilli. The diagnosis of fungus infection in the absence of clinical data, physical, and roentgenological findings is not justified by finding fungi in the sputum, because Aspergillus and Penicillium may develop in a short time in sputum left on the laboratory table. Harmless saprophytic fungi are not uncommonly found in the mouths of apparently healthy people. Therefore, before sputum is collected, the mouth must be thoroughly cleansed with saline solution and the sputum collected and examined at once. Certainly there is need of an intensive study of these infections, especially the classification of their pathologic properties.

While certain types of mycotic infections are found in circumscribed geographical areas in this country, any one of them may occur in any part of the country at any time. Some parts of the country are more conscious of fungus diseases and the profession is constantly on the alert, for instance in California, especially in the San Joaquin valley, because of the occurrence of coccidioidal granuloma.

In this issue there appears a classic contribution by Dr. Arthur Penta. One need only study the article to realize the vast amount of work he has done to present such a wealth of material on fungus diseases of the lungs. Dr. Penta's comments should be kept in mind by every diagnostician confronted with an obscure pulmonopathy. DISEASES OF THE CHEST is proud to publish this article as a beginning, to fulfill a promise in an editorial comment last month.

R. C. M.

Fungous Diseases of the Lungs*

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The study of the mycotic infections of the lungs makes up one of the most interesting chapters in the field of non-tuberculous diseases of the chest. In their close resemblance, both as to the symptomatology and radiological findings with that of tuberculosis, the pneumomycoses offer a challenge to the diagnostic ability of the internist, chest specialist and radiologist. Since in tuberculosis, the tendency today is to lay ever greater stress on methods of investigation which will enable an early diagnosis to be made, even though it be presumptive only, there will be correspondingly a greater delay in carrying out diagnostic procedures, extremely essential in the differential diagnosis of the two conditions.

Clinically, these pulmonary infections are of interest, mainly because of their resemblance to tuberculosis and undoubtedly occur more often than is generally suspected or recognized. As in tuberculosis, the chief symptoms are cough, loss of weight, night sweats, fever, dyspnea, purulent sputum and even hemoptysis. Moreover, the physical signs are compatible with a tuberculous infection, except that, in general, tuberculosis has a predilection for the apical regions, whereas the mycoses invade chiefly the middle and lower pulmonary fields. From a radiological examination no definite help can yet be expected, except that atypical shadows in radiograms of the lungs, suspected of being tuberculous, should promote more decisive bacteriological investigation, and the carrying out of a tuberculin test, which if negative, may prove of some diagnostic value.

During the past decade, numerous articles have appeared in the literature describing the various forms of pulmonary mycoses. It is a significant fact that in many of the reported cases, the diagnosis was established either very late in the course of the disease, or it was confirmed at autopsy. Because of the general delay in the diagnosis, the mycotic infections carry a very high mortality. During the past year, the author has seen several fatal cases of chronic pneumomycoses, in which a tentative diagnosis of tuberculosis had been previously made. In spite of the fact that the sputum in these cases had been repeatedly negative for tubercle bacilli, yet, not until very late in the course of the disease, had any thought been given to the possibility of this type of infection. The sooner it is realized that the final diagnosis of the mycoses rests with the laboratory, which should be employed as soon as possible, the greater will be the opportunity to effect a complete cure in many of these cases.

Historical Consideration

A search of the available literature dealing with the subject of fungi and fungous disease, reveals that the science of mycology was in existence long before that of bacteriology. It may be said to have begun in the days of Charles II,[1] when Hooke, in 1677, constructed a magnifying lens with which he examined the yellow spots so often present on the leaves of the damask rose and found that they consisted of filamentous fungi, which he believed arose from decaying matter, by a process of spontaneous generation. This initial discovery soon was followed by much work and a considerable number of published articles appeared in the scientific periodicals of the time. However, it was not until the discovery of the thrush fungus by Lagenbeck in 1839, that parasitic fungi in man commenced to attract attention. In 1843, Charles Robin classified this fungus as Oidium albicans. In the same year (1839) soon after Lagenbeck announced his discovery, another important fungus was found, the fungus of Flavus, by Schonlein. In 1844, the fungus of ringworm was discovered by Gruby and two years later, Eichstedt, discovered the fungus of Pidyriasis versicolor.

The science of mycology continued to attract attention until the great discoveries by Pasteur[2] and Koch in the field of bacteriology. This immediately brought the study of bacteria to the foreground and mycology

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was placed in the background where it has remained until recent years.

Mycological and Clinical Classification

Since the time of Robin,[2] Wernicke,[3] Busse,[4] Gilchrist and Stokes,[5] Rixford,[6] Montgomery[7] and Ormsby, Castellani[1] and Ashford, many attempts have been made to classify and identify the fungi pathogenic for man. In recent years Jacobson,[2] Dodge,[8] Stovall,[9] Smith[10] and his co-workers, have added greatly to our knowledge of this subject. In a study of the fungi, in which one finds that there is so much disagreement among the students of the subject regarding the botanical and pathogenic classification, it seems best to consider these organisms in connection with the disease that they are known to cause.

For the purpose of clinical study the pneumomycoses may conveniently be divided as follows:

Yeast-Like Fungi

In their simplest form, these reproduce by budding and may form a mycelium.

a) Saccharomycete
b) Monilia
c) Torula
d) Oidium
e) Blastomycete
f) Coccidioidal Immitis
g) Sporothrix

Mold-Like Fungi

The fungi of this group are characterized by the presence of a stalk with a spore bearing head, which forms fruiting branches and which support specialized cells called conidia.

h) Aspergillus
i) Penicillium
j) Mucor

Higher Bacterial Forms

The fungi of this group are characterized by branching mycelia, which break up into segments as conidia with clubbed ends and radiating threads.

k) Actinomycete
(Acid fast and non acid fast)
(anaerobic and aerobic[11])
l) Nocardia
m) Streptothrix

Bronchomoniliasis

Monilia infection of the lungs represents achronic and slowly progressive inflammation in which pathogenic monilia is understood to play a cardinal etiologic role. The pulmonary form is caused by a yeast like fungus, which falls under the classification of Monilia Albicans. The organism is oval in shape and measures from three to ten microns in diameter. It reproduces by budding and produces septate hyphae which intertwine to form a mycelium.

The condition was first recognized by Cas-

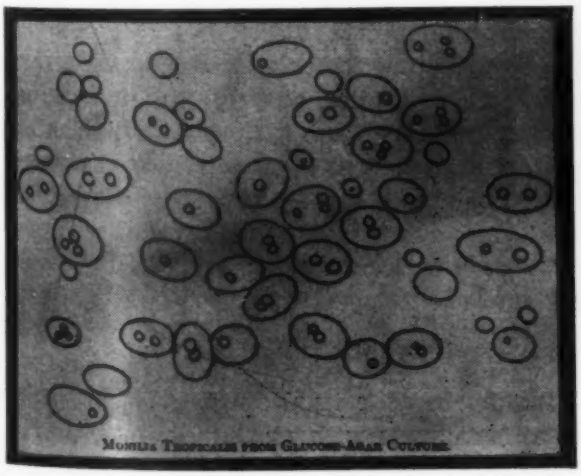


Figure 1
Monilia Tropicalis of Castellani.

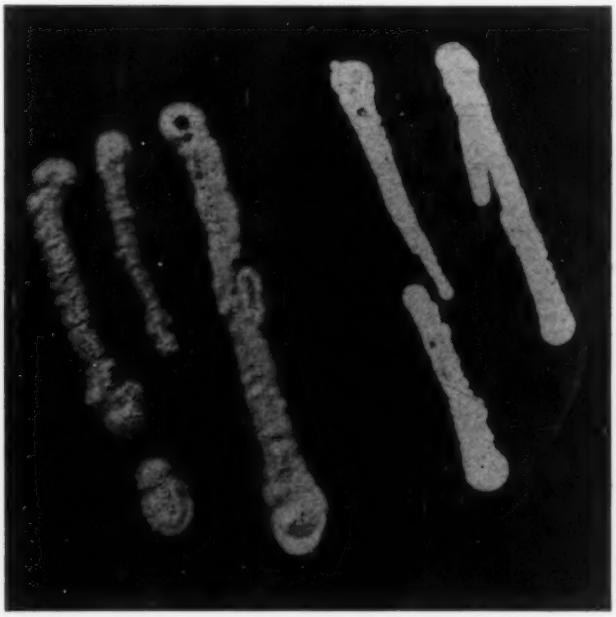


Figure 2
Shows appearance of Monilia cultured on Sabouraud's medium. B.—Monilia which is smooth in appearance as compared with A.—Blastomyces which has a fuzzy outline.
Courtesy of Dr. David T. Smith

tellani[12] in 1905 among the tea workers of Ceylon and, for a time, thought to be a tropical or sub-tropical disease. Numerous cases have since been reported from various parts of the world. The first instance of infection to be observed in this country was the case reported by Boggs[12] and Pincoff in 1915 in the Bulletin of Johns Hopkins Hospital. Bronchopulmonary moniliasis is no longer considered a rare disease, although the diagnosis must be made with extreme caution since the organism is often found in association with many types of bacteria in common respiratory infection, particularly in the sputum of patients suffering from pulmonary tuberculosis. The organism is extremely saprophytic and may, if the pulmonary tissue resistance becomes markedly lowered, find fertile soil to completely overgrow the primary bacteria.

Mode of Infection

Monilia is resistant to drying, and like the tubercle bacilli, may live indefinitely in dust and dry environment. The occurrence of this condition among the tea tasters and the coolies working in the dust of tea factories in India, among the pigeon feeders who handle dried bird food, among the peddlers of dried fruit and straws in Egypt, strongly points, as in tuberculosis, to inhalation as the most probable means of transmission.

Bronchomoniliasis may be recognized in one of three forms, the mild, the intermediate, and the severe.

Figure 3
Moist preparation from bile from experimental animal having generalized moniliasis infection, showing budding forms, septate hyphae and mycelium formation.
Courtesy of Dr. W. D. Stovall

In the mild type the patient merely complains of a slight cough without temperature elevation or the appreciable physical signs of pulmonary disease. The sputum is scanty and mucoid in character. The diagnosis usually made at this time is that of chronic bronchitis. As the condition progresses, the cough becomes more marked, the sputum increases in amount and the patient begins to complain of asthmatoid-like wheezing. In many instances, the diagnosis is changed from that of chronic bronchitis to that of asthmatic bronchitis and eventually these patients are referred to the allergist for treatment.

In the intermediary form, the clinical symptoms and physical signs are more exaggerated. There is a persistent low grade fever, the cough is more troublesome and the entire picture may closely resemble an early pulmonary tuberculosis.

The severe form of the disease is chronic in type and usually terminates fatally. The pulmonary involvement may be unilateral or bilateral and there is frequently an associated pleural involvement. The general clinical picture is that of pulmonary tuberculosis. In this type, as in the intermediary form, there is usually a yeastlike odor to the sputum. This is a very important clinical symptom and should be closely watched for in sputum from chronic pulmonary cases, in which there is repeated absence of tubercle bacilli.

The sputum of patients suffering from bronchomoniliasis is usually copious and has been described by various authors as "curdy," "lumpy" and "gruel-like." Not infrequently the sputum is hemorrhagic.

Except that this disease usually involves the middle and lower pulmonary fields, the radiological studies are not distinctive and simply reveal diffuse pulmonary infiltration with or without cavity formation. The entire radiological picture is generally interpreted as: (1) advanced pulmonary tuberculosis; (2) suppurative pneumonitis; (3) mycotic pneumonia.

Diagnosis and Treatment

Diagnosis—The final diagnosis of bronchomoniliasis rests with the laboratory,[13] which should be employed as soon as possible. The history of chronic pulmonary infection, with repeated absence of tubercle bacilli from the

sputum, should lead one to consider the possibility of a mycotic infection. A very important clue is sometimes given by the yeast like odor of the sputum. It is generally agreed by the medical mycologists that M. albicans is the only species of Genus Monilia which is pathogenic to man, and should be regarded as responsible for the development of pulmonary moniliasis. Sputum from suspected cases of tuberculosis should routinely be examined for fungi. If the first examination reveals no tubercle bacilli, the sputum should then be cultured on Sabourauds Media. In hospitals and sanatoriums, where a trained bronchoscopist is available, it is recommended that the sputum, to be cultured, be obtained by bronchoscopic aspiration, thus avoiding the possibility of oral contamination.

Treatment—Potassium iodide is the drug of choice in this condition, as it is for many of the other mycoses. The best results are obtained when, at the beginning of the treatment, the drug is given in small doses. The author prescribes five grains three times daily and gradually, by the daily addition of three grains, the dosage may be brought up to sixty to eighty grains three times daily. If, during the oral administration, the patient becomes nauseated and unable to retain the drug, the drug is temporarily discontinued and 10 cc. of a two per cent sodium iodide solution is given intravenously for a period of several days. Ethel iodide inhalations is another method of iodide therapy and excellent results have been obtained by using this method alone in preference to the use of the oral potassium iodide administration.

In the mild bronchial form excellent results are sometimes obtained by the intratracheal instillation of a forty per cent iodized oil. In one case treated by the author, in which the patient could not tolerate the oral administration of potassium iodide, four instillations of five to ten cc. of lipiodol were given at weekly intervals.

Smith[14] and his co-workers have recently called attention to the similarity of many of the pathological and clinical features of the various pulmonary mycoses to tuberculosis, and suggest that an allergic state, similar to the hypersensitiveness seen in tuberculosis, would not be surprising. They further call attention to the value of skin testing with the causative fungus before any form of therapy is considered. Iodides are given cautiously and only if the patient shows a negative or weakly positive skin reaction. If the patient exhibits a marked skin reaction, an attempt is made to reduce the sensitivity by vaccine therapy before iodides in any form are given. From his experience he has found iodides distinctly harmful if the patient is strongly allergic.

Torulosis

Torulosis is caused by a yeastlike fungus, torula histolytica, that reproduces only by budding, without mycelial or endospore formation. Torulae are found widely distributed in nature. They are found on trees, flowers, fruits and insects, from grasses, and they have also been recovered from canned butter and from canned milk. The torula histolytica, when obtained from fresh material, such as sputum, pus or spinal fluid and examined under the microscope instained, may easily be mistaken for lymphocytes. They are ovoid or spherical cells, measuring three to fifteen microns in diameter, and are enclosed by a definite cell wall which stains well with methylene blue.

A study of the reports of the recorded cases[2] of systemic torulosis reveals that the infecting parasites have, primarily, a predilection for the tissues of the cerebrospinal system. The symptoms resulting from the

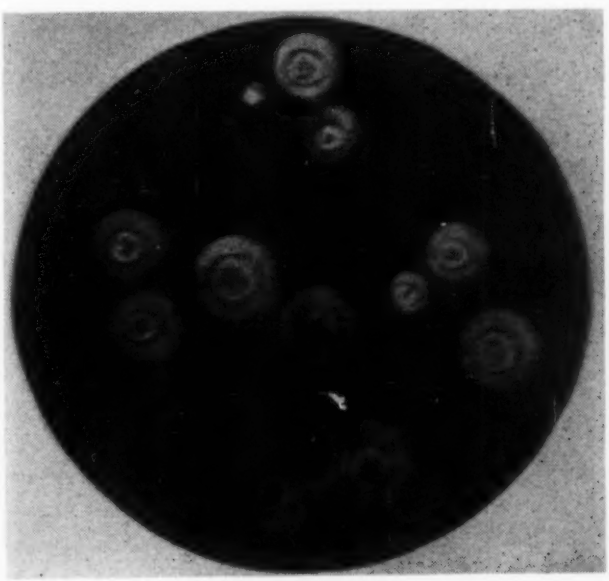


Figure 3-A
T. histolytica. Fresh preparation from lung of mouse 16 days after intraperitoneal inoculation.
Courtesy of Dr. A. J. Vadala

central nervous system invasion closely resemble the symptoms of tuberculous meningitis, intracranial neoplasm or abscess. The last two conditions are so realistically simulated that subtemporal and suboccipital decompressions have been erroneously performed in an effort to establish a diagnosis.[33]

Primary pulmonary torulosis is a rarity, and when found, is usually an associated complication and secondary to cerebrospinal torulosis. In view of the fact that torulae are widely disseminated in nature, it has been suggested that the portal of entry is by way of the respiratory and digestive tracts.[34]

Once the condition is diagnosed, no time should be lost in instituting massive iodide therapy.

Blastomycosis

Blastomycosis, commonly known as Gilchrist's disease, is caused by a yeastlike fungus, which appears in the lesion as an oval or spherical body, having a diameter of ten to twenty microns consisting of finely granular protoplasm. It is enclosed in a double contoured, highly refractive hyaline capsule. Multiplication in the tissues takes place by budding, however, some mycologists have reported reproduction by sporulation. On examination of cultures, spherical or oval budding cells, fruit bearing aerial hyphae and mycelium may be seen.

Blastomycosis seems to attack people of the industrial classes, chiefly, and males in a much larger proportion than females. The high incidence of infection in the male sex suggests that the natural reservoir of the fungus is in nature. Unfavorable hygienic surroundings, according to Stober, seems to play a determinative role in its causation. Martin and Smith in a recent complete study of the condition state, that although patients infected with this fungus have been found in all decades of life, no systemic infections have thus far been described in a patient under the age of twelve years or over the age of seventy.

Mode of Infection

Inhalation of contaminated dust or air probably plays the most important role in the transmission of the fungus deep into the respiratory tract. Recently, a few cases have been reported in which there was a direct transmission of the disease from man to man. Evans reported a case of a pathologist, who received a puncture wound on his finger while performing a necropsy on a case of systemic

Figure 4
Culture of Blastomyces after two weeks incubation on Loeffler's blood serum, showing double contoured hyaline capsule of organism, budding forms and septate hyphae.

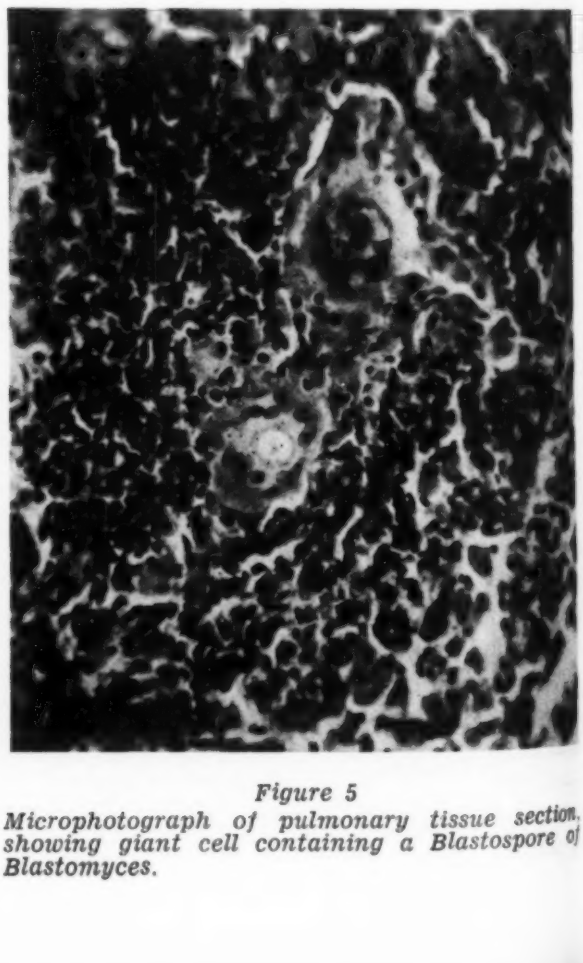


Figure 5
Microphotograph of pulmonary tissue section, showing giant cell containing a Blastospore of Blastomyces.

blastomycosis. A primary infection developed at the site of the needle puncture and four months later blastomyces were demonstrated by biopsy and culture.

Mode of Onset

The cutaneous manifestations, which are a characteristic feature of pulmonary blastomycosis, may precede the onset of pulmonary symptoms. In their absence, the condition is generally confused with that of tuberculosis. In a recent survey of the reported cases to date of pulmonary blastomycosis, nearly half have had no evidence of cutaneous lesions.

Pulmonary Involvement

Blastomycotic infection of the lungs constitutes the most frequent form of the systemic type of the disease. The clinical manifestations of the disease may have an acute or rapid onset, or the initial symptoms may resemble those of a cold or mild influenza and be so transient and mild as to escape attention on the part of the patient. When acute in type, the infection is usually ushered in with a chill, pain in the chest and symptoms of an acute respiratory infection, which closely simulates the onset of lobar pneumonia.

Diagnosis and Treatment

The course of the disease is chronic with exacerbations and remissions. The symptoms and the clinical course of the disease closely resemble those of pyemia and advanced pulmonary tuberculosis.

The diagnosis can only be definitely established by the isolation and identification of the infecting organism. Frequently, when the skin lesions are present the diagnosis may be established by a recognition of the nature of the cutaneous lesions and the demonstration of the blastomyces in pus from the abscesses, or in a biopsy of the tissue. Early in the disease the roentgenograms, according to Potter,[15] who in 1910 gave an excellent description of the disease, usually show a dense irregular shadow extending from the hilum towards the periphery of the lung. In pulmonary infections of obscure etiology, in which blastomycosis is suspected, a skin test and complement fixation reaction should be done.

Pulmonary blastomycosis is highly fatal, reaching a mortality much higher than that of tuberculosis. In an analytical study of 117 reported cases, Martin[14] and Smith found that the mortality rate was seventy-eight per cent.

The time honored drug in the treatment of blastomycosis is potassium iodide. The course and method of treatment is similar to the one previously outlined for the treatment of bronchomoniliasis.

Martin and Smith recommend skin testing with standardized Blastomyces vaccine before any form of therapy is considered. From their experience they have found that iodides are distinctly harmful if the patient is strongly allergic. Before instituting any form of iodide therapy in patients who show a marked allergic reaction, they recommend that an attempt be made to reduce the sensitivity by giving small desensitizing doses of vaccine.

Coccidioidal Granuloma

Coccidioidal granuloma is a chronic infectious disease caused by the fungus, Coccidioides immitis. It presents itself as a well defined disease of the skin, or as a general infection involving both the skin and the internal organs. It is protean in its clinical manifestations and often presents a clinical picture closely resembling that of pulmonary tuberculosis and blastomycosis, both in symptoms and physical signs. The etiologic fungus, which morphologically closely resembles the blastomycete, appears in the tissues and in the pus from granulomatous lesions, as an oval or spherical body, surrounded by a double contoured hyaline capsule. The size varies from five to fifty microns in diameter. It differs from the blastomycete chiefly in mul-

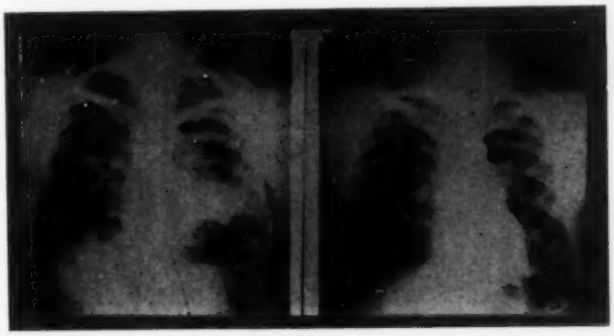


Figure 6
Roentgenogram of patient with Blastomycosis, which responded to several weeks of intensive iodide therapy.

tiplying in the tissues by sporulation, instead of by budding, although some mycologists have observed budding in fresh preparations of pus.

In a statistical study of the disease, by far the largest number of reported cases have been from southern California and from the San Joaquin Valley. Recently a small number of cases have been reported from other portions of the United States.[32] The condition was first described in this country by Rixford[6] in 1895. Persons of all ages and either sex may be affected. The highest incidence of the disease appears to be in regions where there is prolonged hot, dry weather, favorable to the dissemination of the spores. In 1936 the State Department of Health of California reported that since the initial case in 1895, a total of 450 cases with 224 deaths have occurred.

As in blastomycosis,[13] cutaneous lesions may precede the onset of the pulmonary symptoms. However, it is more common in coccidioidal granuloma to obtain a history of respiratory infection several weeks before the appearance of the external lesion.

Dickson[16] described a condition called "valley fever," characterized by a cold or bronchopneumonia, often with a relatively high fever and the appearance of painful erythema nodosum. This, he stated, was the primary infection with coccidioides.

Trauma seems to be a predisposing factor and lesions often develop at the site of the traumatized area. Involvement of the epiphyseal ends of the long bones is very common in this condition. Many of the cases also develop large subcutaneous fluctuating abscesses from which pus can be aspirated with ease. It was through the courtesy of Dr. Newton Evans,[13] pathologist at the Los Angeles County Hospital, that the author had the good fortune several years ago to see several such cases in which there were present many large nodular subcutaneous fluctuating masses.

From a study of the roentgenograms of many of these cases Evans and Ball[17] make the following comment: "A diffuse shadow at times simulating pneumonia, occurs in many cases and involves the right lower lobe twice as frequently as any other part of the lung field, though it may occur in any portion, and twice as frequently in both hilar regions as in one. In many cases the lesions are those of a disseminated miliary tuberculosis."

Differential diagnosis of coccidioidal granuloma offers the following difficulty:

1) Miliary bronchopneumonia
2) Miliary tuberculosis—acute or chronic
3) Carcinomatosis
4) Second stage silicosis

As in tuberculosis, it is believed that the primary focus of coccidioidal granuloma may remain dormant in the lungs for many years before becoming active. As in tuberculosis,

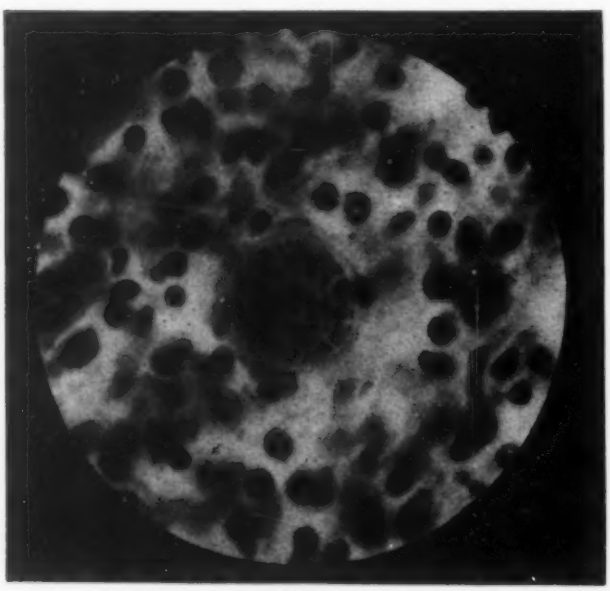


Figure 7
Coccidioides immitis in tissue section of lung, showing double contoured hyaline capsule, with formation of endospores.
Courtesy of Dr. N. Evans

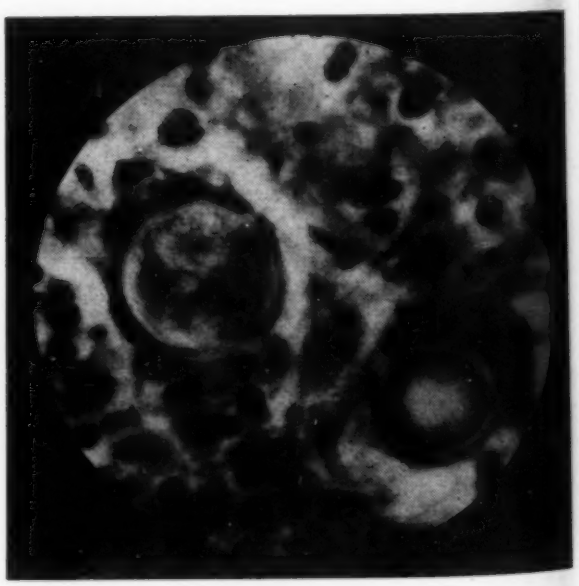


Figure 8
C. immitis in stained tissue preparation, showing organism containing typical endospores.

the period of incubation of this disease is unknown.

The pulmonary form is usually fatal and all attempts at treatment have proved unsatisfactory. In the skin form Ball has obtained encouraging results from the local application of iodine in concentrated form. Tomlinson[18] and Bancroft expressed the opinion that the use of antimony and potassium tartrate, in addition to roentgen therapy, is of value.

In a number of cases treated by Jacobson[2] he obtained fair results by intramuscular injections of colloidal copper combined with cutaneous injections of coccidioidin. Whenever possible, surgery should be applied.

Sporotricosis

The pulmonary form is occasionally seen in this country, though by far the greatest number of cases have come from Europe. The largest number of reported cases in this country have occurred in the Mississippi River basin. The causative agent is a yeastlike fungus of either the Schenkii or Beurmanni type. It multiplies by budding, and in cultures, it forms a mycelium composed of freely branching septate hyphae, which in turn give rise to secondary conidia.

Infection may take place under various conditions and through a variety of agencies. Infected plant or vegetable matter carrying the organisms directly into an area of broken skin or mucous membrane constitute probably the most common source of infection. Foerster[2] reported a series of cases in which the infection was acquired by pricking with the thorn of the barberry shrub. Certain insects, notably flies, wasps, and ants, frequently carry and harbor the sporotricha parasites and the bite or sting of these insects may carry the organisms in the tissues and cause active infection.

The cutaneous lesions, which develop in this condition, are difficult to differentiate from the primary lesions of syphilis, cutaneous

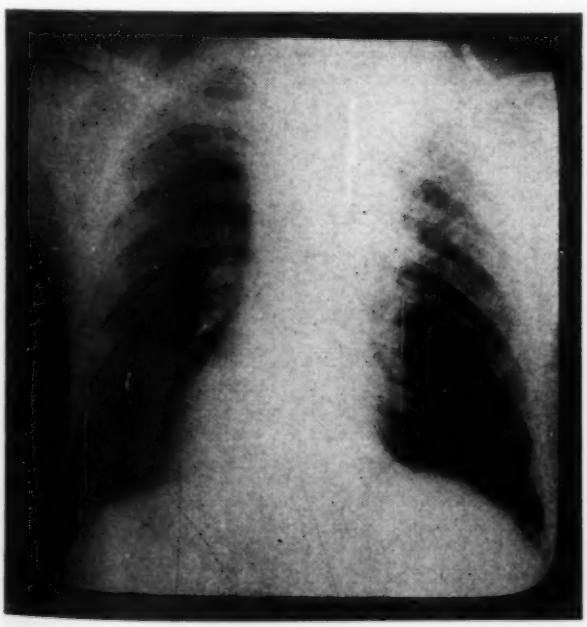
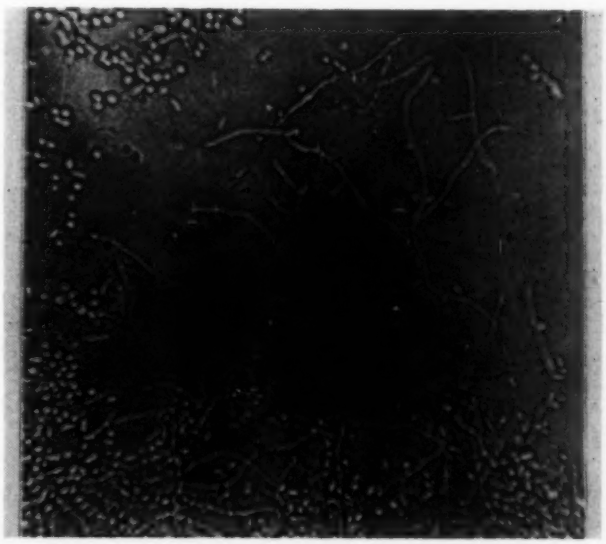
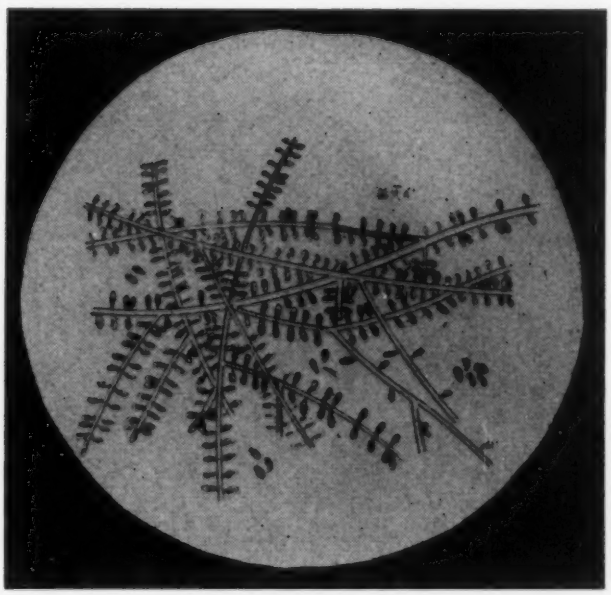


Figure 9

Roentgenogram of patient with Coccidioidal granuloma. Case terminated fatally. Figures 7 and 8, from autopsy specimen of this case.





Figures 10 and 11

Sporotrichum, showing freely branching hyphae and mycelium.

tuberculosis, and the ulcero-glandular type of tularemia. The fungi[13] of the Sporothrix group are very sensitive to the iodides and many of the reported cases have shown a complete cure following a short course of treatment. In the more resistant cutaneous lesions, unfiltered x-ray radiations are used in combination with the iodides.

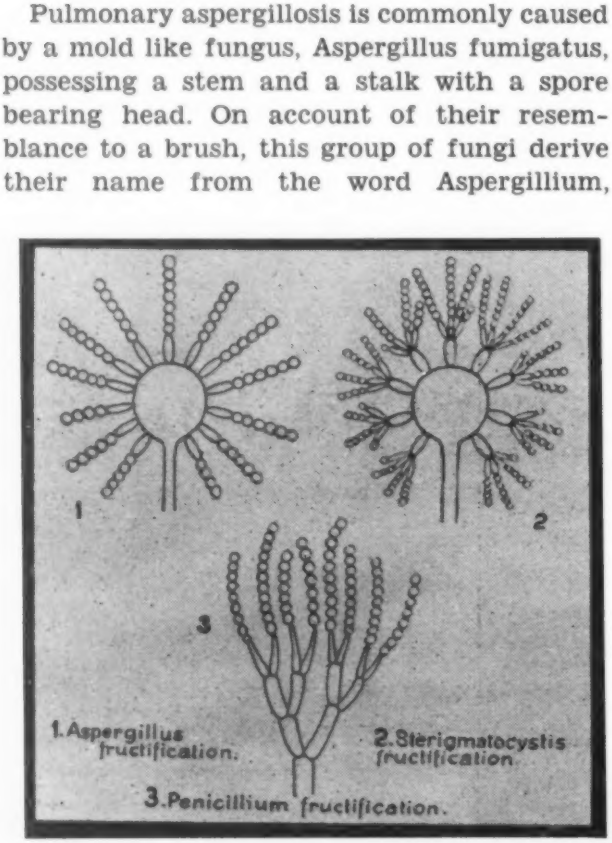
Aspergillosis

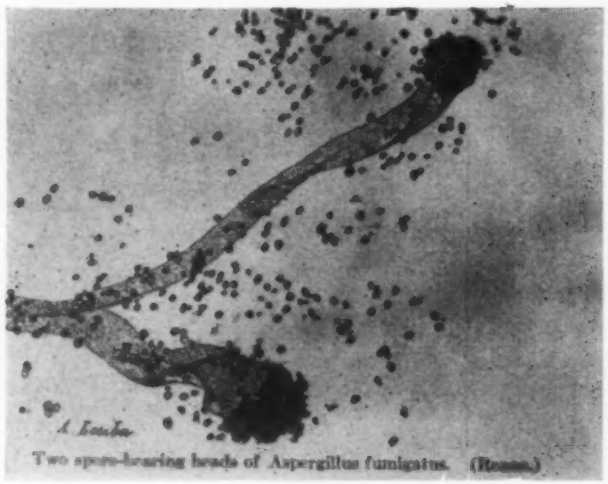
Pulmonary aspergillosis is commonly caused by a mold like fungus, Aspergillus fumigatus, possessing a stem and a stalk with a spore bearing head. On account of their resemblance to a brush, this group of fungi derive their name from the word Aspergillium, meaning a brush which is used in the Catholic church for the sprinkling of Holy water.

There are three varieties of pathogenic Aspergillus: A. Fumigatus, A. Flavus, and A. Niger, which under conditions of lowered bronchial pulmonary resistance, may cause an infection in the respiratory tract. The infection caused by these molds frequently runs a chronic course and the causative parasites seem to have a special affinity for the tissues of the pulmonary system. Occasionally the skin, sinuses and the external auditory canal are also involved. In this group of fungi there also are many non-pathogenic forms, which are used to good advantage commercially, for the ripening of roquefort cheese, the production of citric acid, etc.

The first case of aspergillus infection in man was reported by Bennet[20] in 1843. Virchow[21] first determined the identity of the parasites in 1856. Dieulafoy[22] reported the occurrence of Aspergillosis among the pigeon feeders of France. Renon[23] described the same condition among the workers in the hair sorting industry and isolated A. fumigatus as the causative agent. In all of the above reported cases the disease terminated fatally. Widal,[24] in 1890, described clinically several cases of pulmonary aspergillosis occurring in persons who were engaged in fattening pigeons for the Paris market.

Mary Lapham,[25] in 1926, reported ten cases




Two spore-bearing heads of Aspergillus fumigatus. (Renon.)

Figures 12 and 12-A
Aspergillus—showing stalk with spore bearing head. The basal stem is not shown in this photograph.

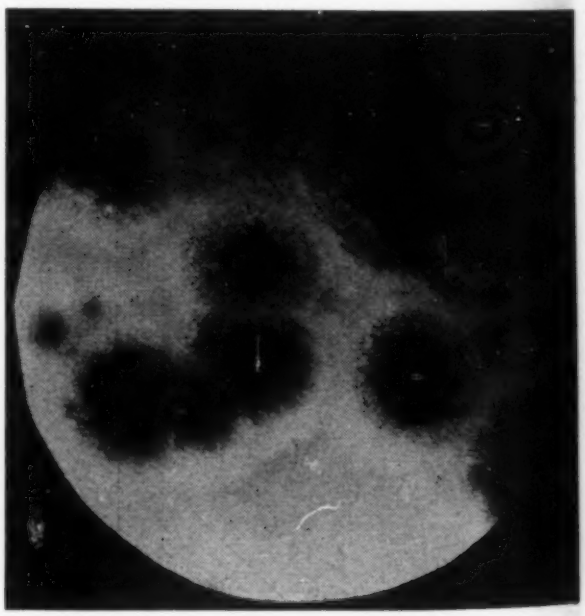


Figure 13
Showing colonies of A. fumigatus growing on Sabouraud's medium.

of primary pulmonary aspergillosis from an obscure village in the Blue Ridge Mountains, and divided the cases into two groups: the wet or parenchymatous type and the dry, or interstitial type. She also called attention to a definite relationship to asthmatic attacks in certain cases.

Most pathologists describe the pulmonary form as falling into two characteristic groups, a superficial and a deep form.[25] In the former are included cases of bronchitis, catarrhal or asthmatoid which run a fairly benign form. The deep, or ulcerative type, depends upon the dosage and the ability of the endotoxins of the mold to cause necrosis of lung tissue analogous to the action of tuberculin in causing caseation in pulmonary tuberculosis. The asthmatic type of aspergillosis has resulted in the addition of a new chapter to the field of allergy. Allergists are well aware of the frequency of aspergillus sensitivity in asthma and allergic rhinitis. Today, no allergic study is complete unless the skin testing for molds is carried out.

Pulmonary aspergillosis, clinically and pathologically, so closely resembles pulmonary tuberculosis that it usually escapes recognition and is diagnosed as tuberculosis. The only roentgenological finding which may be of diagnostic value is, that in Aspergillosis, as in other mycotic infections, the infiltration is prone to be basal.

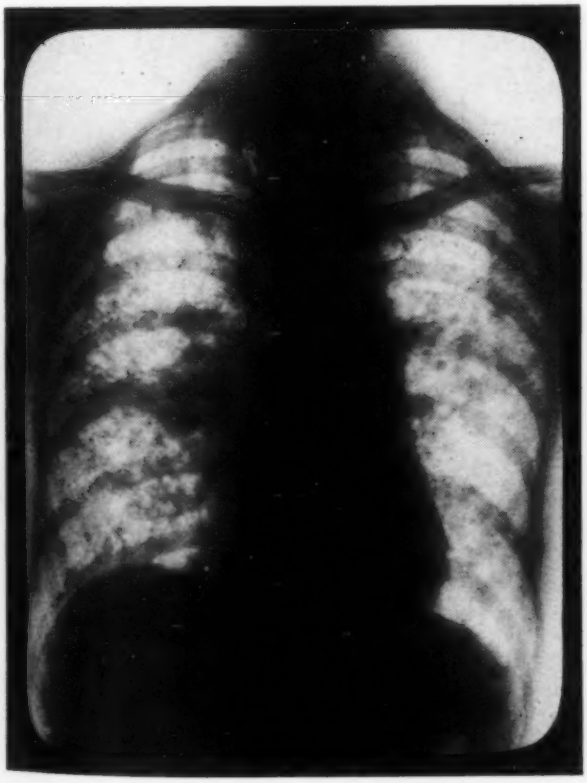


Figure 14
Pulmonary aspergillosis—fatal case. This patient was in a Sanatorium and condition was previously diagnosed as tuberculosis.

Climatic and regional conditions may have some bearing on the development of this disease. In certain parts of the United States, Aspergillus infection does not seem to be of the severe pathogenic type. In a public health survey of the iron mines in the Pitcher, Oklahoma district, in which many chest roentgenograms were taken, Sayre[27] and Merriweather were puzzled to find in many of the roentgenograms of apparently healthy workers, discrete, densities, like tubercles, throughout both lung fields. A careful history taken from many of these workers revealed that they had lost no time from their employment. From the sputum they were able to isolate: A. fumigatis fisheri and A. niger. Antigens from both of these fungi were made and, when used, only the A. niger caused a dermal reaction.

When the above roentgenograms were submitted to a group of eminent roentgenologists, the diagnosis was as follows:

1) Chronic miliary tuberculosis, which had healed by calcification
2) Pneumonoconiosis
3) Calcium metastasis
4) Pneumomycosis

Opie, in commenting upon the miliary

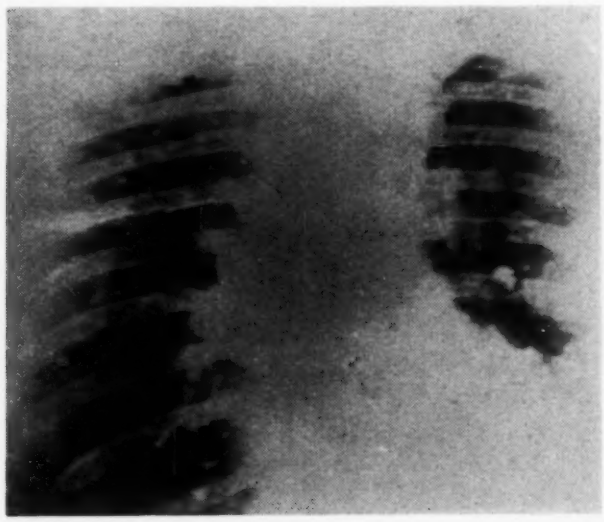


Figure 15
Roentgenogram of one of the workers employed as a wheat thrasher. A. niger repeatedly cultured from sputum. Note the discrete densities, like miliary tubercles, distributed throughout both lung fields.

appearance of these x-ray films gave the opinion that the condition was one of inactive miliary tuberculosis, stating that many more cases recover from miliary tuberculosis than is believed. In a similar survey of the wheat thrashers of Oklahoma and Nebraska, the same condition was found and it was nicknamed "Wheatina."

Actinomycosis

Bollinger first described this disease in cattle and showed that it was due to a vegetable parasite to which Harz,[21] because of its radiate structure, later gave the name of "Strahlenpilz"[28] or Actinomyces. In 1878, Israel[1] discovered the fungus in man, and later Ponfick[29] pointed out the identity of the human and bovine infections. The first case of the disease to be recognized in this country was reported by John B. Murphy in 1885. In 1923 Sanford collected a total of 678 cases of actinomycosis from all the available sources in the United States and expressed the opinion that the number of cases represented only a small proportion of the actual number of victims suffering from this disease. Since Sanford's[2] comprehensive study, many more cases have been reported from all portions of the country.

Actinomycosis may be caused by any one of several species of fungi of the genus Nocardia, Actinomyces or Streptothrix. The diagnosis of actinomycosis, in any of its forms, is ultimately dependent upon the finding of the characteristic sulphur like granules containing the ray fungus. This causative agent is present in the lesion and in the pus in the form of spherical or irregularly rounded, grayish or yellow granules. When these so-called sulphur granules are crushed between slide and cover glass and examined with the microscope under high power, one sees an indefinite mass of tangled fibers and debris. Pus cells are found at the center and at the periphery there is a dense network of interlacing filaments, which at their extreme margin, show the refractive club or rays. It is important that one sees both the rays and mycelium before establishing a definite diagnosis.

Pulmonary actinomycosis is invariably fatal,

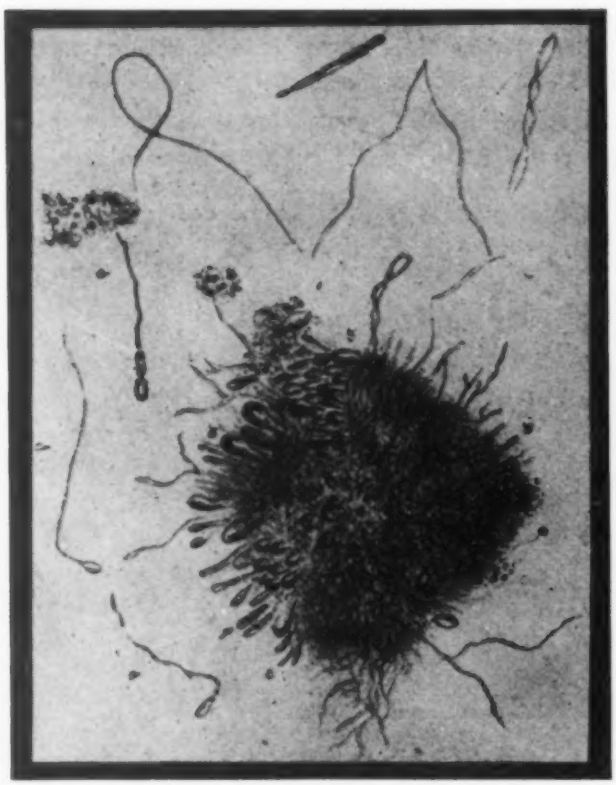


Figure 16 (J. Israel)
Actinomyces granule showing mycelium with club shaped bodies at the extreme margin.

Figure 17
Crushed actinomyces granule from fresh sputum unstained, under high power magnification showing the clubs or rays. In culture these are not seen.

and although this condition is often confused with tuberculosis, the clinical and pathological course is quite different. There is no other pulmonary condition in which there is a tendency on the part of the disease to burrow its way in all directions. From a single lesion in the lungs one sees many sinuses radiating in all directions. The involvement of the neighboring organs, by direct extension, is a striking feature of this disease. Invasion of the pleura and peripleural tissues is almost invariable, and usually leads to the formation of adhesive pleurisy. Erosion of the ribs, perforation of the intercostal spaces in one or more places, and superficial thoracic abscesses are often found. Invasion of the pericardium and the mediastinum, with erosion of the vertebra, takes place with regular frequency.

Israel[23] has divided the clinical course of the disease into three stages. In the first, or broncho-pulmonary stage, the process does not extend beyond the limits of the pulmonary tissue. Incidentally, it is in this stage that the condition might be amenable to surgery, for Actinomyces are usually anaerobic and with the entrance of air, which follows the free opening of the many sinus tracts and the resection of the circumscribed diseased tissue, a complete cure may be brought about. Unfortunately, one never sees a case in this early stage. Involvement of the pleura marks the beginning of the second, or the pleurothoracic stage, while invasion of the thoracic wall terminates in the third or fistulous stage. It is in this stage that we most commonly see the condition. This classification presents a useful picture of the usual progress of the disease.

The medical treatment of this condition makes up one of the gloomy chapters in the history of medicine. Because of the seriousness of the condition, numerous attempts

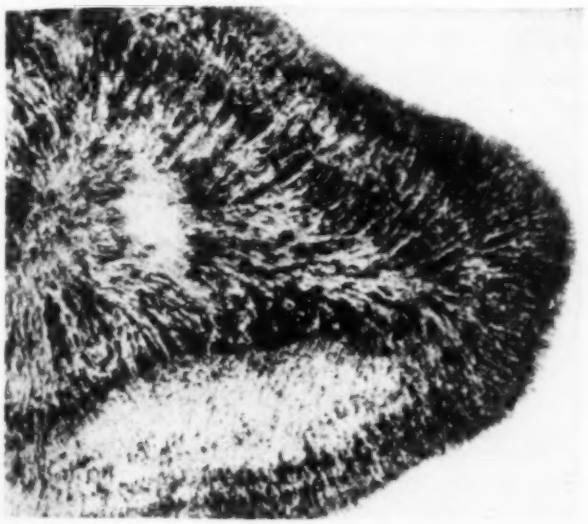


Figure 18
Crushed actinomyces granule showing the radiate structure of actinomyces bovis.

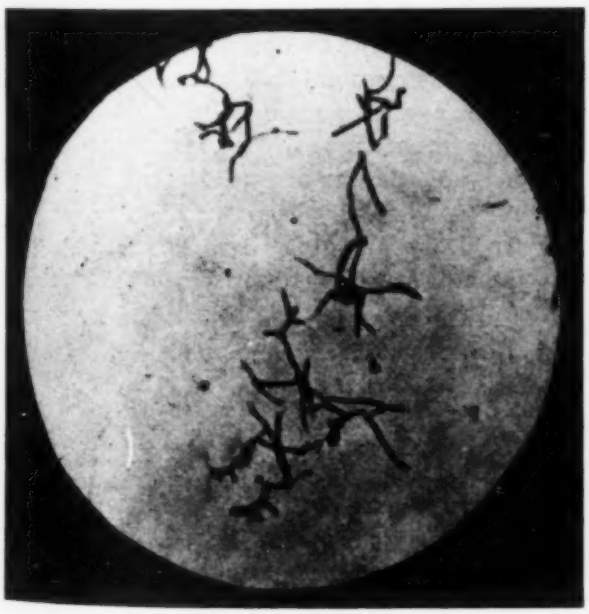


Figure 19
Stained actinomyces from culture showing branching filaments.

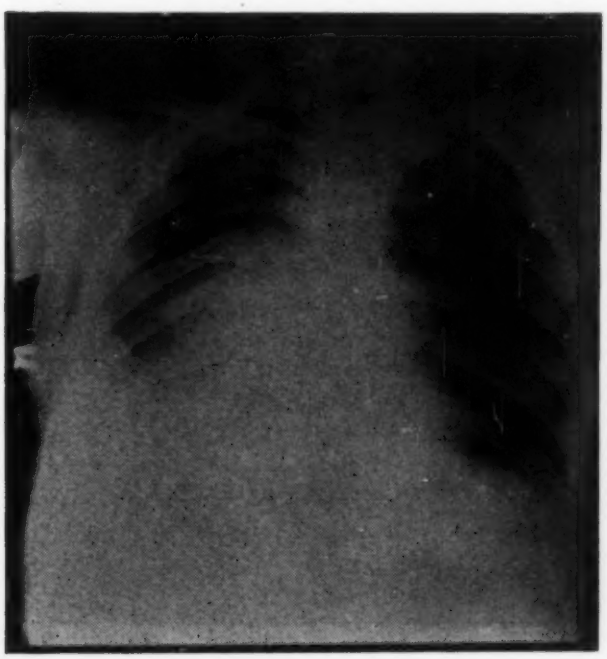


Figure 20
Roentgenogram of patient with pulmonary actinomycosis. Note the clearness of the apical regions.

have been made to discover some therapeutic agent, which would arrest the progress of the disease and alleviate the sufferings of the patient. As yet, however, nothing has been discovered to accomplish this end with any degree of certainty. Myers, in 1937, reported the successful treatment in five of his six cases of actinomycosis affecting different portions of the body by the oral administration of thymol. Employing Myers' method, Etter[30] and Schumacher in 1939, reported a case of pulmonary actinomycosis successfully treated by thymol. Their patient received 30 grains of thymol daily for a period of seventeen days. Other investigators have reported successful treatment by the use of massive doses of potassium iodide. Because of the numerous respiratory infections responding to sulfanilimide therapy, some investigators have also recommended the use of this drug in the treatment of this serious disease.[31] In addition to iodide therapy, Bevan[2] advocates the use of copper sulphate in one-quarter grain doses several times daily. Non-specific protein therapy has been employed with success by Epstein in two cases of Actinomycosis.

Figure 21

Photograph of patient same as in figure 20, showing involvement of the chest wall, with the formation of many fistulae. It is in this terminal stage of the disease, that the diagnosis of Actinomycosis is usually made.

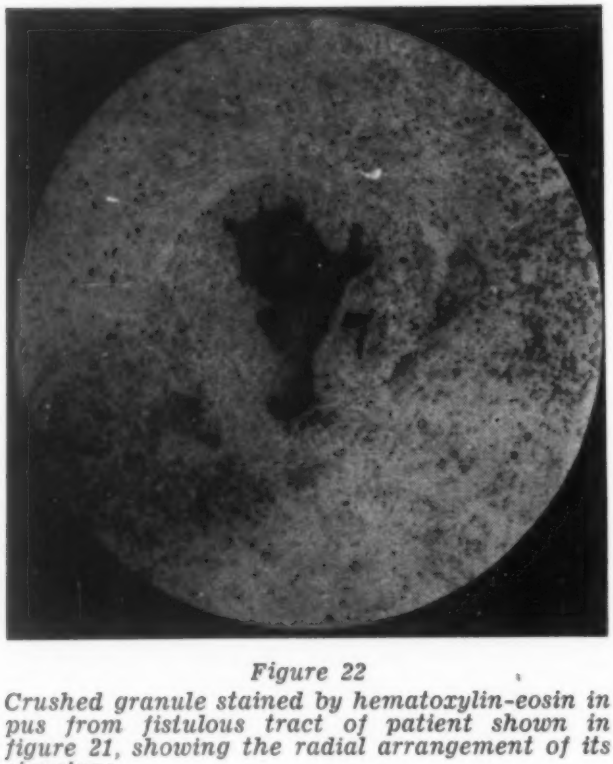


Figure 22

Crushed granule stained by hematoxylin-eosin in pus from fistulous tract of patient shown in figure 21, showing the radial arrangement of its structure.

The only satisfactory method in dealing with the accessible type of this disease is radical surgery. In view of the rapid progress being made today in the field of thoracic surgery, there is some hope, that the pulmonary form of this disease may be successfully treated by the thoracic surgeon.

Conclusions and Summary

In this brief review of the mycotic infections of the lungs, the author has attempted to emphasize:

1) The close resemblance of this type of infection to that of pulmonary tuberculosis.

2) Pneumomycotic infections undoubtedly occur more often than is generally suspected or recognized, and in obscure pulmonary infections, the possibility of this condition should always be considered.

3) The importance of the laboratory as an indispensable means of establishing the early diagnosis.

4) Once the diagnosis has been definitely established, iodide therapy should immediately be instituted.

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An Eleven Year Study of the Treatment of Pulmonary Tuberculosis by Artificial Pneumothorax

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This review is based upon the records of patients treated by artificial pneumothorax chiefly in the private Nursing Cottages of Browns Mills and partly in the Burlington County Tuberculosis Sanatorium at New Lisbon, from January 1, 1930 to January 1, 1941. Two hundred and fifty-seven cases were studied, of which one hundred and five were males and one hundred and fifty-two were females. The great majority were white adults with far-advanced disease.

Of the 257 cases treated, 177 received unilateral pneumothorax alone, 80 required either bilateral pneumothorax or some surgical intervention concurrent with the pneumothorax treatments, such as internal pneumonolysis or phrenic interruption, or after the pneumothorax was abandoned, such as extra-pleural thoracoplasty, extra - pleural pneumothorax, some form of phrenic nerve operation, etc. Pneumothorax refills were given to 53 patients for a period of from 3 to 5 years inclusive, and to 20 patients for a period of from 6 to 10 years inclusive. Fifty-three patients have lived for a period of from 5 to 11 years from the time of the initial treatment, of whom 37 received unilateral pneumothorax alone, 2 received bilateral pneumothorax alone, and 14 required the assistance of some form of thoracic surgery. One hundred and forty-nine patients received treatments for only 1 year or less. Sixty-six of these patients died within 1 year from the time of the initial treatment. It is interesting to note that only 4 patients out of the entire group of 257 expired afer the 5 year period.

In this survey, I do not intend to outline

TABLE I

NUMBER OF CASES TREATED

Sex	Number of Patients	Living	Dead
Male	105	63	42
Female	152	85	67
Total	257	148	109

TABLE II

CLASSIFICATION OF DISEASE

Sex	Minimal	Moderately Advanced	Far Advanced
Male	1	5	99
Female	0	11	141
Total	1	16	240

TABLE III

METHOD OF TREATMENT

Sex	Unilateral Pneumothorax Alone		Bilateral Pneumothorax or Pnx Plus Surgery	
	Living	Dead	Living	Dead
Male	43	33	20	9
Female	52	49	33	18
Total	95	82	53	27
	177		80	

complicated technical statistics. As you notice by examining Table IV, I am merely reporting the length of time that artificial pneumothorax was given and the span of life of the 257 patients studied. From these simple statistics, many conclusions as to the value of pneumothorax in treating pulmonary tuberculosis are derived. I have not gone into detail about the condition of the patients, such as whether the sputum was positive or negative, whether the patient had an effective collapse or not, whether the patient was considered as Arrested, Quiescent or Active after a certain period of time, whether there were any complications, etc. By giving the length of time that the patients have received the treatment, and by giving the span of life of the patients, the effectiveness of the pneumothorax in the group as a whole can readily be ascertained. Naturally, the ineffective pneumothoraces were discontinued as soon as possible in favor of some other form of collapse therapy. For statistical purposes, I am disregarding the treatment of the patients prior to pneumothorax, even though this may be very important and may give a reason for the success or failure of the pneumothorax therapy. All statistics in this review commenced at the time of the initial treatment. For this reason, the span of life of the patients herein discussed will be short-

TABLE IV

SUMMARY OF TREATMENT

Description of Treatment		Sex	Up to 3 Mos.	3 Mos. to 6 Mos.	1 Yr.	2 Yrs.	3 Yrs.	4 Yrs.	5 Yrs.	6 Yrs.	7 Yrs.	8 Yrs.	9 Yrs.	10 Yrs.	11 Yrs.
Length of Time Pneumothorax Given No. of Cases		M	36	6	17	13	8	8	8	3	3	0	1	2	0
		F	33	16	41	22	10	11	8	7	3	0	0	1	0
Span of Life From Onset of Pneumothorax No. of Living Patients	Unilateral Pneumothorax Alone	M	2	2	6	9	3	6	5	2	3	1	2	1	1
		F	0	2	9	4	4	11	5	9	3	2	1	2	0
	Bilateral Pneumothorax Alone	M	0	0	1	0	0	3	1	0	0	0	0	0	0
		F	0	0	0	3	0	3	0	1	0	0	0	0	0
	Pneumothorax Plus Thoracic Surgery	M	0	1	3	2	4	2	0	2	0	0	1	0	0
		F	0	1	4	3	2	5	5	3	1	2	0	0	0
Span of Life From Onset of Pneumothorax No. of Deaths	Unilateral Pneumothorax Alone	M	12	6	7	6	0	1	1	0	0	0	0	0	0
		F	7	10	16	8	4	3	0	1	0	0	0	0	0
	Bilateral Pneumothorax or Pneumothorax Plus Thoracic Surgery	M	1	1	1	3	0	2	1	0	0	0	0	0	0
		F	0	2	3	9	3	0	1	0	0	0	0	0	0

er than most statistics on tuberculous patients. However, there is no doubt about the value of this form of treatment, especially since I have been able to follow the progress of many patients for a period of from 5 to 11 years. Most of the deaths occurred within 2 years after the initial treatment, a fact which indicates that the collapse was ineffective or that serious complications had developed.

As seen in Table II, two hundred and forty cases were far-advanced. Perhaps this may explain why so many patients were not benefited by pneumothorax, a method of treatment which is considered the simplest and safest by the medical profession. However, there are certain risks involved and complications are possible. "Ambulatory pneumothorax," where the initial treatment is given in the clinic and the patient is permitted to go home and attend his duties, may be perfectly satisfactory in cases where an effective, selective collapse can be obtained easily and quickly. But, in order to render all possible beneficial aid, especially in far-advanced cases, it is best to have the patient enter a sanatorium or its equivalent institution, for the initial treatment and for as many refills as may be necessary before it is safe for the patient to travel for further treatment. If this is not possible, arrangements should be made with the patient for any possible surgical intervention, if the pneumothorax therapy is not effective. As seen in this survey, 149 patients had their pneumothorax therapy discontinued in 1 year or less. This time, of course, is not sufficient to arrest the disease. This means that such patients, provided their condition is satisfactory, must have some other form of collapse therapy; otherwise they are obliged to resort to the "rest cure" and other details involved in the usual sanatorium regime. In a sanatorium the patient not only receives his pneumothorax refills, but also procures the "rest" and education, which are necessary for his ultimate "cure" and means of taking care of himself when he returns home. When the collapse becomes satisfactory and the sputum is negative and the important symptoms disappear, the patient can be discharged with instructions to return for his treatments at the intervals designated by the physician. It is not very difficult to make the patient understand the importance of these refills.

Sometimes, certain patients would rather "cure" longer by means of "rest," or others would rather submit to more radical surgery than to take the pneumothorax treatments over a period of years. These patients consider the repeated treatments a disadvantage for pneumothorax therapy. I would consider this method of treatment an advantage to the tuberculous patient, because it makes him conscious of the disease and will cause him to take better care of himself with less chance for relapse or for having the misfortune of developing an active lesion in the contralateral lung. A cavity in a lung which has apparently healed may possibly re-open at any time. By keeping this cavity collapsed over a period of years by means of pneumothorax, there is less danger of its re-opening after the pneumothorax has been abandoned than if the cavity had healed spontaneously.

There are many differences of opinion as to how long pneumothorax refills should be continued. The period ranges from one year to as long as the patient is able to receive the treatments. In reviewing the cases, I have come to the conclusion that the time should not be too short nor too long. Each patient should be treated individually. Perhaps, the goal of a far-advanced case should be five years. If the time is too short, relapse is apt to occur. If pneumothorax is continued when an ineffective collapse is present, serious complications, such as empyema and bronchopleural fistula, are possible. Therefore the ineffective pneumothorax should be abandoned after a trial of from two to four months, and other forms of collapse therapy attempted. Then, again, towards the end of the therapy, say after 3 years, an attempt should be made to let the lung re-expand.

There is another advantage in attempting to induce artificial pneumothorax, even though it proves to be unsuccessful or ineffective. The great majority of tuberculous patients will consent to having a needle inserted between the ribs into the pleural cavity, but how many will consent to a major thoracic operation as soon as the diagnosis is made? Nevertheless, after an attempt at pneumothorax, it becomes much simpler to explain to the patient the value of some other form of collapse therapy in order to help "cure" him sooner and more effectively. In 1940 it

was almost as easy to get consents for thoracoplasty as for artificial pneumothorax; but in 1930 it was difficult to persuade the patient to have a thoracoplastic operation.

Of course, many an ineffective pneumothorax with adhesions can be made effective by means of internal pneumonolysis. If there is any doubt as to whether the adhesions can be cut, the patient should receive the benefit of that doubt by a thoracoscopic examination. If the pneumothorax cannot be made effective, it should be abandoned. If the patient survives serious complications, more radical thoracic surgery is indicated. In this survey a great number of patients were in such critical condition that surgical intervention was contra-indicated. But in most of those cases where internal pneumonolysis or some other form of surgery was performed, the patients were able to pass the 3 or 4 year mark from the onset of pneumothorax. Even though the pneumothorax was ineffective at first, it paved the way for further treatment.

Many patients have bilateral cavitations and require bilateral pneumothorax. Sometimes a contralateral lesion develops during the successful pneumothorax treatment of one lung and the patient will then require bilateral pneumothorax. It is advisable to get a fairly effective collapse on one side before attempting the other side, even if you must resort to a pneumonolysis. However, if one side is effective and the other side is ineffective, here again, the ineffective pneumothorax should be abandoned for some other form of collapse therapy, provided the patient's condition warrants it.

Although pneumothorax therapy is a very effective means of combating pulmonary tuberculosis, it has its limitations. The medical profession must be prepared for all the new modern methods of treatment as soon as they are introduced.

The Roentgenology of Gastro-Intestinal Tuberculosis

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Tuberculosis of the bowel is a most common complication of pulmonary tuberculosis. Pathologists report intestinal lesions in from 50 to 80 per cent of all cases of pulmonary tuberculosis in which autopsy records are available. Roentgen ray studies reveal no such percentage. Samson[1] claimed 25 per cent, working in a tuberculosis institution. It is our impression that here we are finding demonstrable lesions in about 10 per cent of the tuberculous cases studied.

To explain the disproportion let us look for a moment at the pathology of pulmonary tuberculosis. Boyd classifies tuberculosis in a very simple manner:

A) *Primary*—which is found in children and not common in this country.

B) *Secondary*—when the tubercle bacilli reaches the lung it is arrested by the lymphoid tissue and is carried to the region of the apex of the lobe involved. A period of activity follows which may be devoid of symptoms. The defense mechanism of the host gains the ascendancy and the lesion heals without clinical manifestation.

We think that this same process occurs in the bowel and accounts for many of the small microscopic and macroscopic lesions which are found at autopsy. These small lesions never result in a process which has gained sufficient virulence to produce clinical or Roentgen signs of enteritis.

We think that to carry this analogy further will clarify many of our ideas of intestinal tuberculosis. Boyd further classifies secondary pulmonary tuberculosis as fibrocaseous tuberculosis. In this type, the number of the tubercle bacilli gaining access to the lung is greater or the strain is more virulent than in the initial infection. The resistance of the host to the infection is violent, consequently destruction and attempts at repair are present, simultaneously. The picture is dependent

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upon the balance of the processes of destruction and repair. If the resistance of the patient is stronger, there is less destruction and more healing with fibrosis. If the destructive process is stronger, there is more cavitation and tissue destruction. We think that a similar process takes place in hyperplastic tuberculosis of the bowel.

The infection usually starts in the ileocecal region, for it is here that the preponderance of lymphatic tissue is found. The tubercle bacilli, when they reach this segment, are taken up by the phagocytes. The phagocytes carry the bacilli into the regional lymphatics, or they may be retained in Peyer's patches and the solitary lymph patches. These structures become the seat of tubercle formation. The tubercles break down, caseating or forming tuberculous ulcers. In the intestine, as in the chest, the picture is dependent upon which force is the stronger. If the resistance of the patient is great enough, healing takes place. If the resistance is not sufficient to completely overcome the infection but is equally balanced with the destruction produced by the infection, then the destruction is arrested and there is an attempt to heal the lesions, resulting in a marked thickening of the wall of the bowel. The destruction of tissue produces a ragged, narrowed asymmetrical lumen. There is a complete lack of peristaltic activity. The bowel wall is thickened and ridged to fluoroscopic palpation. Often the intestine proximal to the lesion is enlarged and the passage of the barium is delayed.

These findings lead to the conclusion that the bowel is involved in a process in which tissue destruction and formation are operating simultaneously because of the narrow ragged lumen. This rules out a new growth for in tumor formation the tissue growth is polypoid and while the lumen is irregular it is smoothly irregular as contrasted to the raggedness of tissue destruction.

To distinguish between hyperplastic tuberculosis and non-specific granuloma is many times impossible but in the cases of tuberculosis we have observed that the inflammatory tissue production has resulted in thickened walls and marked irregularity of the lumen. We have had very little trouble in the differentiation. When a frank pulmonary tuberculosis is present we may assume the pathology in the bowel to be tuberculous. When the differential diagnosis cannot be made by Roentgenologists, clinical and laboratory methods will help in the identification.

Ulcerative tuberculosis of the bowel is subdivided into a primary form which occurs rarely in this country. Bockos, Tumen and Kornblum[2] reported two cases in 1940 which exhibited involvement of the jejunum, ileum and colon. These are the only two cases reported in this country of generalized ulcerative tuberculosis of the intestine that we have found and since they are so infrequent we do not wish to discuss this type except to mention it for completeness of classification.

Secondary ulcerative tuberculosis of the intestine is rare in children. In adult life it is not uncommon. The pathology of this process predetermines the Roentgen picture. An active pulmonary tuberculosis is always present and repeated inoculations of the bacillus are received in the intestine. These organisms are picked up in the ileocecal region by phagocytes just as they are in the thorax. They are carried into the lymphoid structure of Peyer's patch and solitary follicles. Here tubercles are formed which break down, producing ulcers, the floor of which is usually the submucosa, although ulceration may penetrate to the muscularis. The surrounding mucosa is red, hyperemic and edematous. Extension takes place along the course of the lymphatics. The ulcers tend to encircle the bowel because of the lymphatic pattern. The affected portion of the bowel becomes spastic and very irritable. The irritability is the basis for the Roentgen picture, for as the barium arrives at the involved ileocecal region it is passed through the ulcerated area so rapidly that repeated observations show no barium filled lumen in the affected segment. As we visualize the affected portion of the bowel we see only small flecks of barium caught in the contracted folds of bowel wall or in the crater of the ulcers. The bowel proximal and distal to the affected segments is well filled. If the process is long continued and there is some attempt at healing with cicatrix, then the bowel proximal to the lesion may be somewhat distended due to partial obstruction. The segment infected may vary in length. We have never seen multiple areas. This, of course, is explained by the tendency to spread by continuity of surface.

When the study is made by retrograde filling, the picture is identical except that the barium passes the involved segment and into the unaffected ileum, while the reverse is true when the barium is administered orally.

We cannot allow this opportunity to pass without doing a little missionary work in behalf of more thorough preparation of patients prior to study of both the small and large bowel. Careful attention to the instructions will pay dividends in more reliable information; information which will show much detail concerning the condition of the mucous membrane and muscular activity that can never be gained when the bowel is filled with normal content.

In preparing a patient we ask that he be given a cleansing enema two hours before examination. Food is withheld for twelve hours. The intestine is then clean at the time of examination. The patient is given eight ounces of barium and water to which tragacanth and malted milk have been added. These two ingredients slightly delay the passage of barium from the stomach. This delay permits us to visualize larger areas at each observation. The patient is seen at 15 to 20 minute intervals until the meal has passed into the colon. This usually consumes from 5 to 7 hours and during this period we visualize every loop. The motility of the bowel as well as the appearance of the lumen and mucosa are described for it is impossible to put all of the detail on films.

To study the ileocecal region by means of the enema, the patient is instructed to take a cleansing enema two hours before he presents himself for study. If it is possible and the appointment is early he is requested to fast the morning of the examination and his evening meal preceding study is restricted. We find this method of preparation is satisfactory and does not leave the bowel irritable, while the use of castor oil, as recommended by Weber for colon studies, leaves the colon very irritable.

In closing, we would like to emphasize that it is our rule to demonstrate actual tissue change before suggesting tuberculous enteritis to referring clinicians. Hypermotility and bowel spasm may be suggestive of intestinal tuberculosis, but these manifestations accompany many pathological processes which do not have the tubercle bacillus as the causative agent.

Again we would like to emphasize that the proper preparation of the patient for study is most important. None of you would consent to examine a stomach Roentgenoscopically unless the stomach was empty. The importance of the clean colon is just as great.

1130 S. W. Morrison Street.

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1 Brown and Samson: *Intestinal Tuberculosis*, Lea & Febiger.
2 Bockos, Tumen and Kornblum: *Annals of Int. Med.*, Vol. 13, Feb. 1940.

Practical Pointers for the General Practitioner in Diagnosing Tuberculosis

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Joplin, Missouri

Much is said nowadays about the increasing complexity of medical practice, but practically nothing is said about how medical practice may be simplified. If a busy physician is to keep his feet on the ground he must use procedures that give a maximum amount of information with a minimum of time and energy expended.

For the diagnosis of chest diseases an enormous number of diagnostic signs and tests are described in the textbooks. Among others, I learned in medical school about amphoric resonance, the cracked pot sound, Gairdner's coin test, the metallic tinkle, Hippocratic succussion, Litten's phenomenon, Broadbent's sign, to mention but a few. As far as the practical practice of medicine is concerned, knowledge of all these tests should be confined to medical historians.

Too often in articles concerning the diagnosis of pulmonary tuberculosis one reads a long list of symptoms all of which occur in tuberculosis, but not one of which is characteristic of that disease. Appended to the

end of this list is the vague admonition that the presence of these symptoms should "cause the physician to keep in mind the possibility of pulmonary tuberculosis." This is probably good advice, but not much help in making a diagnosis.

What are the chief aids in making a diagnosis of tuberculosis of the lungs? By all odds the x-ray examination must be given first place. There can be no doubt that an x-ray film of the chest made with modern technique will disclose more cases of pulmonary tuberculosis than any other method of examination.

It must be remembered, however, that x-ray films are not clicked out of x-ray machines as automatically as candy bars out of a slot machine. Nor is the diagnosis printed on the film in legible characters for anyone to read.

There is some variation of opinion among experts as to what constitutes an ideal film. However, one may describe approximately the characteristics of a good film of the chest. It should be made with an exposure of not more than 1/10 second and with a target film distance of not less than six feet. In order to take a picture with this time and distance, a milliamperage of 100 is necessary. It is, however, possible to take a presentable film with a time of 1/5 second and approximately 50 milliamperes. In the finished film the area occupied by the heart shadow and the area below the diaphragms should be only faintly darkened by the reduced silver salt. The spine should be seen very faintly, if at all, through the heart shadow. If the individual vertebrae can be made out, the film is over-exposed. The extreme outer portions of the film not covered by the patient's body should be completely black; otherwise, the film is under-developed, for any exposure to x-ray sufficient to penetrate even a small chest should be enough to completely blacken the uncovered portions of the film. The normal lung markings should be visible well out toward the lateral portions of the chest.

A common fault of amateur x-ray operators is to over-expose films and to under-develop them. Except for very gross pathology, a film that is over-exposed and then "saved" by under-development is absolutely worthless for diagnostic purposes.

Given a good film, the next step is to learn what constitutes the normal shadows seen in the lung fields. The major portion of these shadows are cast by the pulmonary blood vessels, chiefly the pulmonary artery. On a flat posterior-anterior film of the chest the pulmonary arteries are seen to enter the lung at the hilus. The main branch, shortly after entering the lung, curves downward, gradually becoming smaller as it approaches the base of the lung. Branches are given out in all directions as the vessel traverses the lung. The heaviest branches of the pulmonary vessel are seen in the lower parts of the lungs along the margins of the cardiac shadow. If a good film of a normal chest is closely scrutinized, this pattern is very easily seen. It resembles the inverted branches of a tree. The branches are heaviest at the roots of the lungs, gradually diminishing in size as the periphery of the lung is approached, finally forming small twigs which completely fade out at the extreme periphery. These shadows are *not* due to the bronchi as many men seem to believe, judging by their use of the term "bronchial markings." It is only occasionally that a bronchus is visualized by the x-ray without the use of contrast media.

It must be remembered that in the living patient the blood vessels extend in all directions—downward, laterally, upwards, forward, and backwards, and on a flat x-ray film the shadows of these vessels are compressed into two dimensions. If this fact is kept in mind, the loops and annular shadows that are thus formed will not so often be mis-called lung abscesses, tuberculous cavities, and bronchiectasis. It must also be kept in mind that the so-called descending trunk shadows along the borders of the heart are much heavier than in other parts of the lungs because they are due to the large vessels supplying the bases of the lungs, which are the largest and more actively functioning portions of the lungs. Failure to appreciate this fact leads to the erroneous interpretation that these shadows represent "increased fibrosis," "bronchial thickening," or "bronchiectasis."

Landmarks are as important in reading x-ray films as in orienting one's self while doing surgery. By keeping the normal pattern of the lung vessel shadows in mind whenever looking at a film, any abnormal shadow will be readily apparent. Tuberculous infiltrations appear as areas of mottling which ob-

scure the normal lung shadows, usually in the upper parts of the lung fields, though they may occur in the lower parts as well.

I do not wish to leave the impression that the x-ray examination is all of the diagnosis of chest disease, but it does settle the all-important question of whether or not there is a lesion present in the lung parenchyma in at least 95 per cent of cases.

Next to the x-ray in importance is the sputum examination. This is the only method by which a diagnosis of tuberculosis may be absolutely proven. However, one must in many cases do without a positive sputum because one does not wish to wait before making a diagnosis until an open lesion is present. Sputum examination is not difficult, and most girls who are intelligent enough to work in a doctor's office are intelligent enough to learn how to examine sputums. The method that I prefer for staining sputum is to allow the smear to stand in a jar of carbolfuchsin at room temperature for twenty-four hours. The smear is then washed with acid alcohol until no more pink color can be removed, then counter-stained with aqueous methylene blue. The bacteria are then seen as the familiar red rods. The most practical method of learning how to recognize the bacilli is to secure a well stained specimen of sputum known to contain tubercle bacilli and study it carefully. However, if the physician does not care to trouble with the examination in his office, most cities of any size have clinical laboratories that will do this work and many health departments provide for making sputum examinations. Repeated sputum examinations are necessary in most cases. In my own practice when, for example, I am attempting to differentiate between a lung abscess and pulmonary tuberculosis I very carefully examine at least ten specimens.

In many cases special measures such as sputum concentration, culture, and guinea pig inoculation will be necessary. In recent years gastric lavage has been used a great deal to recover tubercle bacilli. The organisms have frequently been found in the stomach washings when they could not be found in the sputum. These special measures are, of course, impractical for the general practitioner and require the aid of a laboratory. The point I wish to specially emphasize is that the notation on a patient's record, "negative sputum," in no wise rules out a diagnosis of pulmonary tuberculosis.

Third in order of importance among the diagnostic methods is the history. It must be remembered that there is no symptom characteristic of tuberculosis. It was formerly thought that hemoptysis or pulmonary hemorrhage was most frequently due to tuberculosis of the lungs. In my opinion this belief must be revised. Any inflammatory condition of the lung—severe bronchitis, bronchiectasis, lung abscess, pneumonia—may cause blood to appear in the sputum. Lung tumor may cause bleeding. Congestion of the lungs due to heart disease is a very frequent cause of bleeding from the lungs. Cough obviously gives one no positive proof of tuberculosis. Afternoon rise in temperature is inconclusive. Most normal individuals show a diurnal variation in temperature. The temperature is normally higher in the afternoon than in the morning. With any type of infection there may be enough elevation of temperature in the afternoon to be called fever. Many other conditions cause such symptoms as fatigue, loss of weight, and anemia.

A family history of tuberculosis is extremely important and is found in a considerable percentage of cases of pulmonary tuberculosis. The more carefully the history is taken, the more frequently will a positive family history be obtained. A definite history of acute pleurisy with effusion is also a very significant finding.

The history may not give us much information that will be of use in making a positive diagnosis, but often it gives us leads that are extremely helpful. Though tuberculosis may mimic any chest condition, a carefully taken history will usually disclose the fact that there are some aspects of the patient's illness that are not characteristic of the condition that it resembles such as pneumonia, influenza, acute bronchitis, chronic bronchitis, or lung abscess. Though tuberculosis may undergo acute exacerbations it is characteristically a chronic disease and a careful history will usually show that the patient has had his symptoms many months or years.

Many men may disagree with me, but I rank physical examination last in my list of useful measures in making a diagnosis of tuberculosis. Much may be determined about

(Continued to page 314)

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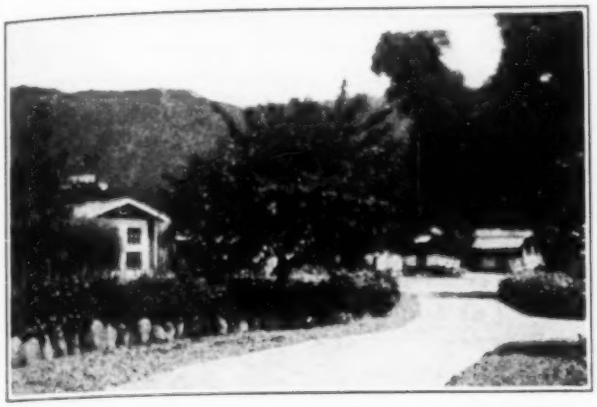

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(Continued from page 312)

the condition of the contents of the chest by a man skilled in physical diagnosis, but I am not speaking to these men. For the average man the x-ray film gives much more accurate information concerning infiltrations, consolidations, and excavation than any amount of inspection, palpation, percussion and auscultation.

The most useful single physical finding in pulmonary tuberculosis is rales. Unless these are brought out in a certain manner, many times they will be missed. The patient should be asked to exhale, cough at the end of exhalation, and then inhale. The characteristic rale is heard with the inspiration that comes immediately after the cough. The procedure described causes all air to be expelled from the alveoli; if there is any inflammation causing an excess of moisture, the alveolar walls adhere to each other and when they are again expanded their separation causes a crackling sound. If this sound is carefully fixed in one's memory, there is little chance of confusing it with such adventitious sounds as crackling of hair on the chest and sounds due to muscle vibrations.

Special laboratory procedures other than the sputum examination are of no help in diagnosing tuberculosis. The condition of the blood is, of course, important in assessing the patient's exact physical condition for the purpose of treatment, but there is nothing in the blood examination that is characteristic of tuberculosis.

There are, of course, unusual situations in the lungs that are difficult to diagnose, even for the specialist in chest diseases, but these situations probably should not remain in the hands of the general practitioner but should be referred to the specialist in the first place.

So much for making the diagnosis of tuberculosis. When the diagnosis is made, then one must, by means of complete blood examinations including a Schilling count and sedimentation tests, observation of the temperature fluctuations, evaluation of such symptoms as the weight loss, night sweats, cough, expectoration, etc., assess the precise status of the patient's disease for the purpose of treatments. But it must always be remembered that none of these things has any value in making a diagnosis of tuberculosis. Too many errors have been made by diagnosing tuberculosis in patients who have "symptoms of tuberculosis."

Many general practitioners seem to feel that tuberculosis is an uncommon disease. Furthermore, they, being closer to their patients than the specialist are loathe to make a diagnosis of a disease which is looked upon with so much horror by the average person. The general practitioner must appreciate, however, that his services are indispensable in the fight against tuberculosis. If he is alert and investigates the chests of all patients in whom the symptoms may be due to tuberculosis, and if he then goes further and advises all of the persons who have been in direct contact with a patient with tuberculosis to have x-ray films made of their chests, he will be performing an invaluable service for his community.

607 Main Street.

Organization News

PENNSYLVANIA CHAPTER MEETS

The Pennsylvania Chapter of the American College of Chest Physicians, which was organized at the time of the annual meeting of the College held at Cleveland on June 2, will hold its first regular meeting at the William Penn Hotel, Pittsburgh on Sunday, October 5th. This is one day prior to the annual meeting of the Pennsylvania State Medical Society. A business meeting will be held at 3:00 P. M. The following scientific program will be presented: Dr. Chevalier L. Jackson of Philadelphia will speak on "Obstructive Atelectasis"; Dr. Childerhose of Harrisburg will speak on "Silicosis"; and Dr. Stites, Superintendent of the State Sanatorium, Cresson, will speak on "Experiences with Pneumoperitoneum in the Treatment of Tuberculosis of the Lungs and Intestines." An informal dinner will be held at the William Penn Hotel at 7:00 P. M., and Major General Reynolds will be the guest speaker at this function. All the members of the College from Pennsylvania and the adjacent states are invited to attend. For reservations, write Dr. Edward Lebovitz, Secretary, Pennsylvania Chapter, American College of Chest Physicians, 501 May Building, Pittsburgh, Penna.